REACTIONS OF STOCK RETURNS TO ASYMMETRIC CHANGES IN EXCHANGE RATES AND OIL PRICES

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Abstract

When an economy does well as a result of crude oil proceeds, it is expected that its financial market records a boost. So, when the economy regresses due to fluctuations in oil prices, its financial market also reacts in tandem. To shed light on the uninterrupted fluctuations, we empirically estimated the effect of changes in exchange rates and oil prices on stock returns in developing countries using the nonlinear autoregressive distributed lag (NARDL) methodology. Results reveal that a 1 percent negative shock to the exchange rate diminished returns significantly by 1.015 percent and 2.191 percent for Egypt and Nigeria respectively whereas, in Tunisia, Morocco, and Tanzania, stock returns increased significantly by 0.118 percent, 0.176 percent, and 1.145 percent respectively. For every 1 percent positive shock to exchange rates in Egypt, Nigeria, Tunisia, Morocco, and Tanzania, returns declined by 1.012 percent, 1.04 percent, 0.015 percent, 0.112 percent, and 0.214 percent respectively. A 1 percent positive shock in oil price negatively influences returns by 0.02 percent, 0.05 percent, 0.18% percent, 1.09 percent, and 0.25 percent in Egypt, Nigeria, Tunisia, Morocco, and Tanzania while a 1 percent negative shock stimulated stock returns by 1.02 percent, 0.128 percent, 0.199 percent, 1.029 percent and 0.091 percent in Egypt, Nigeria, Tunisia, Morocco, and Tanzania respectively. Different policy reaction functions should be executed differently for depreciation, appreciation, and oil price shock to enhance the favorable flow of returns in stock markets.

Keywords: Asymmetric Effect, Symmetric Effect, Oil Price Volatility, Changes in the Exchange Rate, Short-Term Deposit Rate, NARDL Model

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1. INTRODUCTION

Observing distortions that characterized global markets, one would be overwhelmed by a myriad of volatile shocks that confront African nations. However, a double take of these distortions might then come into focus as not randomness but icons of cause and effect. These distortions are amplified as caused by developing and most often, import-dependent markets of Africa (Umoru et al., 2023a, 2023d; Dabor et al., 2023; Gatsi & Appiah, 2020). Markets are riddled with loopholes akin to market disequilibria. An asymmetric effect could be shown when retailers increase prices in tandem with increased distribution or input costs. The asymmetric effect is revealed, however, when reduced cost or input price, does not affect an immediate change in retail price. One could argue the case for asymmetry blaming it on the inventory strategies of retailers as FIFO ("first-in, first-out") will be symmetric to market conditions and LIFO ("last-in, first-out") will be asymmetric (Brown & Yücel, 2000). More striking, however, is the reality that customers or buyers may not have full information about the market in comparison to suppliers or retailers which leaves the fruit of imperfections to blossom and in effect reinforce price asymmetric transmissions

Energy drives economies alas without it, production is impossible. Oil and gas are the global sources of energy accounting for 39.9% of the world's energy usage (International Energy Agency, 2016), powering machines and industries even with the rising interest in renewable energy creation (Gourène & Mendy, 2018). Africa is no different in that its countries could be grouped into oil-exporting and importing countries. Within this dichotomy lies an objective cause of symmetric and asymmetric price transmissions (Umoru et al., 2023b, 2023d). Its effect holds for inflation, reserves, exchange rates, and international output (Umoru et al., 2023c, 2023e; Ratti & Vespignani, 2016). While oil drives production, equities reflect trade and income markers in an economy. When an economy does well as a result of crude oil proceeds, it is expected that its financial market records a boost. It then follows *a priori* that when the economy regresses due to fluctuations in oil prices, its financial market will also react in tandem. According to Xiao et al. (2019), oil prices drive worldwide monetary uncertainties and investors' expectations. It is no secret that oil-producing countries of Africa are heavily dependent on their revenues from crude oil. Oil revenue accounts for most of these countries gross domestic product (GDP). One would not be amiss to say that when shocks do hit the global oil market (prices), the economies of these countries import these shocks by way of price transmissions. We would also go further to state that these crude oil shocks do not only dampen the look of the African economies but also transmutes a volatile effect on its stock markets (Xiao et al., 2019).

The notion of cause and effect on crude oil and stock returns nexus are seldom symmetrically distributed. They are by and large asymmetrical. Across the board, the impulse response functions diverge when one considers increasing trends against decreasing ones. In oil-importing countries, oil price increases escalate production costs and dampen profits which will negatively affect stock performance. However, when oil decreases, the reverse effect is evidenced. The reversal would hold for oil-producing countries as seen in the return of countries in the Gulf Cooperation Council (GCC) (Arouri & Rault, 2012). When crude oil prices increase in these oil-producing countries, revenue moves in an upward trend and suddenly, investors are equipped with more capital to take up positions on stocks (Degiannakis et al., 2013). There is however an underlining limitation in this symbiotic relationship.

Stock prices are valuations that reflect expected earnings. Crude oil prices are vital to the global economy through their influence on cooperating liquidity (Badeeb & Lean, 2018). With increased revenue from crude oil, demand, and profits are expected to be upward trending which excites investors to take up stock options. However, when crude oil revenues deplete which is most often a function of decreasing oil prices, investors would expect a depletion of income and spending which prompts them to short their stocks (Xiao et al., 2019). When these ensue, investors who are not properly hedged would suffer losses. This is exaggerated by the fact that in Africa for example, most investors are interested in the short-run stock analysis due to volatilities caused by socio-political upheavals as well as market fragmentation and policy reversals (Panda et al., 2019). We attempted to investigate the reactions of stock returns to changes in exchange rates and oil prices. The paper contributes to the heterogeneous relation concerning crude oil prices and stock returns as revealed by the cause-and-effect response that oil shocks transmit into stock volatilities in the African markets. Hence, through the application of the nonlinear autoregressive distributed lag (NARDL) model, we provided evidence of the role of changes in exchange rates. Exchange rate variations were found to impose significantly asymmetric effects on stock returns in oil-producing countries in Africa. Using the NARDL methodology, we identified the magnitude of the effects of the aforementioned factors on stock returns in oil-producing African countries. The knowledge provided by this research into the nexus concerning the stock market, foreign exchange, and oil markets can support officials of the government and policymakers in determining the most operational interventions required to mitigate excessive fluctuations and achieve feasible returns. Specifically, the NARDL estimation divulges that positive exchange rate changes influence return significantly albeit negatively with a 1.012%, 1.04%, 0.015%, 0.112%, and 0.214% decline in returns on every 1% positive shock to exchange rates in Egypt, Nigeria, and Tunisia, Morocco, and Tanzania respectively. In sum, our study demonstrated that the exchange rate had both short-run (SR) and long-run (LR) asymmetric impact on stock returns for all countries as appreciation and devaluation in the exchange rate of all countries except Egypt contributed opposing effects (positively and negatively respectively) in determining stock returns. This confirms a non-linear effect of exchange rate changes on returns. The research findings, thus indicate a definitive pattern of impact resulting from oil and foreign exchange (FX) markets volatilities on African stocks. It is therefore remarkable that this paper not only established the existence of asymmetric effects of crude oil prices in African oil-producing countries on stock returns but the current research was also oriented to quantifying the returns effects of volatilities in oil prices, as well as currency depreciation and or appreciation impose on the aforementioned African stock returns. Accordingly, investors and policymakers would find insight into predicting short and long-run trends in returns in the oil-producing African financial markets following variations in FX and oil markets. More importantly, it is desired that stakeholders and investors alike, as well as policymakers, might find this paper useful in understanding, predicting, and forecasting long and short-run trends in the stock markets of oil-producing African nations to eliminate or cushion the risk and uncertainty that behooves global oil prices and its effect on stock market stability and performance.

The next Section 2 is devoted to a review of studies on oil price volatility and exchange rate devaluation in connection with stock markets. Section 3 is the methodology, model construction, and materials. Section 4 presents results from the estimation exercise while Section 5 discusses the results. We concluded the study in Section 6.

2. LITERATURE REVIEW

The stock market is one metric for assessing a country's financial health. The growth of a country's industrial sector is linked to the performance of its stock market which is measured by an all-share index (ASI). The ASI reflects investors' sensitivities to the economic health of the domestic economy. This is because it comprises all trading securities on the stock markets. Oil prices are quoted in US dollars. Considering the landscape on which studies have been carried out to estimate the volatilities in global oil prices and stock performances, one would find a plethora of mixed findings. Most studies have been limited to the fact that crude oil increases will boost stock performances (Zarour, 2006). Building on the flow-oriented exchange rate theoretical standing as recently emphasized by Phylaktis and Ravazzolo (2005) and Kanu et al. (2017) we have a book of empirical works that have also reported the non-linear effect of variations in exchange rates on stock prices.

Just to be succinct, some of the recent studies on stock returns, oil prices, and exchange rates include Sanusi and Kapingura (2022), Mohamed et al. (2022), Ajeigbe (2022), Fasanya and Akinwale (2022), Raju et al. (2021), Gokmenoglu et al. (2021), Caporale et al. (2022), Jaghoubi (2021), Lubis et al. (2021), Kumar et al. (2020), Ali et al. (2020), Shahrestani and Rafei (2020), Köse and Ünal (2020), Mokni (2020), Singhal et al. (2019), Nurmakhanova and Katenova (2019), Khan et al. (2019), Kelikume and Muritala (2019), Badeeb and Lean (2018), Hu et al. (2018), Youssef and Mokni (2019), Roubaud and Arouri (2018), Al-hajj et al. (2018), Nasir et al. (2018), Yeh and Lee (2000), Apergis and Rezitis (2001), Dominguez and Tesar (2006), Koutmos and Martin (2007), Chue and Cook (2008), Hsu et al. (2009), and Miao et al. (2013). Amongst recent works that have reported symmetric effects of exchange rate movements on stock returns are Nieh and Lee (2001), and Phylaktis and Ravazzolo (2005). The results of Sanusi and Kapingura (2022) having based analysis on time-varying vector autoregression (VAR) estimation upheld negative reactions from the stock market to oil prices while additional findings emanating from the study also showed that the exchange rate significantly influenced oil prices in the booming period. According to Ajeigbe (2022), changes in the exchange rate and oil prices are negative risk factors that adversely distress the stock return of the industrial sector and aggregate market.

Fasanya and Akinwale (2022) reported a rising vulnerability of stock returns to fluctuations in the exchange rates and this was attributed to the fact that foreign investors reduce investment risk by globalization as a factor. When structural breaks are accounted for, the effects of *exrv* on sectorial stock returns were not asymmetric (Fasanya & Akinwale, 2022). Basing investigations on a panel VAR (PVAR) model, Mokni (2020) found inverse relations between the daily stocks of firms and changing oil prices. According to Gokmenoglu et al. (2021), there is a linkage between returns and movements in the exchange rate. This linkage made it possible to forecast the path of exchange rates having separated the study sample into pre- and COVID-19 periods respectively. The time-varying results of Caporale et al. (2022) upheld that oil prices had a negative impact on the Brazilian, Indian, South African, and Russian markets. Jaghoubi (2021) reported that the returns from the Russian market are unresponsive to instabilities in the foreign exchange rate and crude oil. Lubis et al. (2021) found an absence of a considerable effect of oil price and exchange rate changes on the Jakarta Stock Exchange Composite Index (JCI).

The NARDL results obtained by Kumar et al. (2020) show that the Indian stock market is negatively driven by changes in exchange rates but positively influenced by movements in oil prices. Based on the generalized autoregressive conditional heteroskedasticity-in-mean (GARCH-M) analysis, Ali et al. (2020) found a negative effect of exchange rate volatility on returns in Pakistan. Similar results were obtained by Antonakakis et al. (2020) for the emerging stock markets. According to Shahrestani and Rafei (2020), the stock market effects of oil price changes are regime dependent. On their part, Köse and Ünal (2020) reported that the effects of oil price movements on returns are negative in Kazakhstan, Iran, and Russia. The report from the study by Köse and Ünal (2020) is similar to the report earlier obtained from the study by Singhal et al. (2019) where it was observed that stock market return effects of changes in the oil price are negatively significant in Mexico. The finding by Khan (2019) shows that the exchange rate movement had negative effects on the stock exchange of Shenzhen. Basing discussions on the asset pricing model, exploration of the nexus concerning stock return at the sectorial level and oil price movements revealed that the variability in global crude oil prices posed a risk factor (Mokni, 2020; Kelikume & Muritala, 2019; Badeeb & Lean, 2018; Hu et al., 2018). According to Ji et al. (2020), the association between the stock returns of the BRICS (Brazil, Russia, India, China, and South Africa) and oil prices is highly unstable.

Nurmakhanova and Katenova (2019) found that oil prices in Kazakhstan had deleterious effects on stock prices. Khan et al. (2019) found NARDL asymmetric effects of oil price movements on stock returns in Shanghai. For instance, while upward movement in oil prices negatively influenced returns, downward movement in the same had positive effects on returns. According to Youssef and Mokni (2019), oil price fluctuations adversely affected oil-imp-exporting nations more compared to its impact on oil-exporting nations as found from the DCC-BEKK model estimation. Roubaud and Arouri (2018) found evidence in favor of a significant linkage between stock returns, and movements in exchange rates and oil prices based on Markov switching and VAR regression modeling techniques. The NARDL evidence of Al-hajj et al. (2018) reveals that fluctuations in crude oil adversely stimulated returns in Malaysia. According to Nasir et al. (2018), the link between stock market return and oil price movements is time-varying.

Oberndorfer (2009) found that rises in oil prices dampened European stock returns. Oil price variations have benefited Liberia and oil-importing African nations (Gbatu et al., 2017; Dutta et al., 2017; Gueye et al., 2019; Gershon et al., 2019). Gueye et al (2019) research also demonstrated how variations in oil prices have different impacts on the economy of sub-Saharan African countries. Before this, Ekong and Effiong (2015) also enquired about the linkage of oil and stock prices in Nigeria using a structural VAR (SVAR) methodology covering 1986 to 2011. They found that the exchange rate was linked with reaction patterns to different forms of Brent price fluctuation, there was no association concerning oil price shocks and exchange rates. Nwani and Okogbue (2017) applied the ARDL equation to the Nigerian market for the period 1985–2014 and found a positive and negligible relationship between currency conversion rate and oil price. Ahmed and Huo (2020) employed a VAR-BEKK-GARCH forecasting model to explore the relationship existing between crude oil, exchange rates, and African stocks for the period 2007–2016. They found that in Botswana, Nigeria, and Zambia, the price of oil directly affects the exchange rate, but it has the opposite effect in Egypt.

On the contrary, using the BEKK model, Bai and Koong (2018) obtained a positive response from the Chinese market to oil supply shocks. Kösedağlı et al. (2021) found positive effects on the sectorial returns of Indian, and South African stock, while oil-gas sector returns effects of exchange rate changes vary across time and countries. Gourène and Mendy (2018) reported evidence of no significant association between stock markets in Egypt, and South Africa and changes in global crude oil prices. On the opposing side was the empirical finding by Ferreira et al. (2019). These authors found evidence of the positive influence of changing oil prices on returns. Some mixed empirical results were obtained by Thorbecke (2019). Al-hajj et al. (2018) studied the impact of oil price innovations on equity market performance. The authors reported that there was no clear empirical link concerning oil market volatility and African markets. The actual data to date has been rather unexpected, even though it is well-accepted in the literature that a price upswing will be good for net oil exporting countries while having a negative effect on net oil importing countries. According to Thorbecke (2019), for some countries, the stock market effects of rising oil prices are positively significant while negative effects on returns were reported accordingly.

3. RESEARCH METHODOLOGY

There are alternative estimation methods that can be deployed to unravel the sensitivity of stock market returns to movements in exchange rates and oil prices. These methods include quantile regression techniques, system estimator (three-stage least squares [3SLS] or full information maximum likelihood [FIML]), linear VAR and ARDL method, structural panel Bayesian VAR (SPBVAR), BEKK-GARCH, VAR-GARCH, etc. Nevertheless, the methodology we have chosen for this paper pegs itself around conducting a descriptive statistical test, unit root test for stationarity, obtaining the appropriate lag through the VAR lag structure criteria after which a NARDL test was carried out to test for asymmetries in both LR and SR forms of our model. Equation (1) is our general specification is an SR relationship between stock market returns (*smtr*), crude oil prices variation (*olpv*), exchange rate devaluation (*exrv*), and short-term deposit rate (*stdr*) in first difference whilst assuming trend stationarity.

$$lnsmtr_{it} = \vartheta_1 + \vartheta_2 ln(\Delta olpv) + \vartheta_3\, ln(\Delta exrv) + \vartheta_4 ln(\Delta stdr) + \mu_{it} \tag{1}$$

As illustrated by Brown and Yücel (2000) for the U.S. gas market, many consumers complained about price asymmetries pegged for the existence of monopolistic tendencies in the petroleum product market. We could go further to state that the asymmetric price transmission principle argues that the shocks to the oil and gas market would not mimic itself in the commodities and stock markets but rather, its innovations would vary in degrees quite apart from each other. One should consider an ARDL model generally specified as:

$$y_{it} = \sum\nolimits_{h=1}^{p} \phi h y_{it} - h + \sum\nolimits_{i=1}^{q_1} \delta_i z_{t-i} + \mu_{it} \tag{2}$$

where y_{it} the function of its lags and on a vector of explanatory variable Z. A generalization for asymmetries by including positive (+) and negative (–) variables:

$$y_{it} = \sum\nolimits_{h=1}^{p} \phi h y_{it} - h + \sum\nolimits_{i=1}^{q_1} \delta_i^{+} z_{i,t-1}^{+} + \sum\nolimits_{i=1}^{q_2} \delta_i^{-} z_{i,t-1}^{-} + \mu_{it} \tag{3}$$

One could also generally define a VAR model as:

$$lnZ_{it} = \psi_1 lnZ_{t-1} + \psi_2 lnZ_{t-2} + \cdots + \psi_q lnZ_{t-q} + \mu_{it} \tag{4}$$

Basing our NARDL specification on our variables of interest in line with Shin et al. (2014) given the conditional error correction form, we have:

$$\Delta lnsmtr_{it} = \gamma_0 + \sum_{i=1}^{p} (\theta_{0,i} \Delta lnsmtr_{i,t-i}) + \sum_{j=0}^{q_1^+} (\phi_{1,j}^+ \Delta lnolpv_{i,t-j}^+) + \sum_{j=0}^{q_1^-} (\phi_{1,j}^- \Delta lnolpv_{i,t-j}^-) + \sum_{f=0}^{q_2^+} (\phi_{2,f}^+ \Delta lnexrv_{i,t-f}^+) + \sum_{f=0}^{q_2^-} (\phi_{2,f}^- \Delta lnexrv_{i,t-f}^-) + \sum_{s=0}^{q_3^+} (\phi_{3,s}^+ \Delta lnstdr_{i,t-s}^+) + \sum_{s=0}^{q_3^-} (\phi_{3,s}^- \Delta lnstdr_{i,t-s}^-) + \theta_1 x lnsmtr_{i,t-1} + \varphi_1^+ lnolpv_{i,t-1}^+ + \varphi_1^- lnolpv_{i,t-1}^- + \varphi_2^+ lnexrv_{i,t-1}^+ + \varphi_2^- lnexrv_{i,t-1}^- + \varphi_3^+ lnstdr_{i,t-1}^+ + \varphi_3^- lnstdr_{i,t-1}^- + \mu_{it} \quad (5)$$

In Eq. (5), we have *lnsmtr* as the logarithm of stock market returns, *lnolpv* as the logarithm of oil price variability, *lnexrv* as the logarithm of exchange rate devaluation, *lnstdr* as the logarithm of the short-term deposit rate measured as deposit interest rate as per month. These signs "+" and "–" denotes measures of the asymmetric impact of each predictor on returns. Such asymmetric impact conveys the impact of both positive and negative changes in the predictors. The decomposition of these effects is as follows:

$$lnolpv_{i,t-1}^+ = \sum_{i=1}^{t} \Delta lnolpv_i^+ = \sum_{i=1}^{t} max\ (\Delta lnolpv_{i,0}) \quad (6)$$

$$lnolpv_{i,t-1}^- = \sum_{i=1}^{t} \Delta lnolpv_i^- = \sum_{i=1}^{t} min\ (\Delta lnolpv_{i,0}) \quad (7)$$

$$lnexrv_{i,t-1}^+ = \sum_{i=1}^{t} \Delta lnexrv_i^+ = \sum_{i=1}^{t} max\ (\Delta lnexrv_{i,0}) \quad (8)$$

$$lnexrv_{i,t-1}^- = \sum_{i=1}^{t} \Delta lnexrv_i^- = \sum_{i=1}^{t} min\ (\Delta lnexrv_{i,0}) \quad (9)$$

$$lnstdr_{i,t-1}^+ = \sum_{i=1}^{t} \Delta lnstdr_i^+ = \sum_{i=1}^{t} max\ (\Delta lnstdr_{i,0}) \quad (10)$$

$$lnstdr_{i,t-1}^- = \sum_{i=1}^{t} \Delta lnstdr_i^- = \sum_{i=1}^{t} min\ (\Delta lnstdr_{i,0}) \quad (11)$$

The unrestricted NARDL model specified in Eq. (5) depicts two types of asymmetries in the exchange rate and oil price deviations, and short-term deposit rate. These include SR asymmetry and LR asymmetry. These climax in two restrictions that can be tested by the Wald coefficient restriction test (Shin et al., 2014):

1) SR asymmetry with the underlying hypotheses given as follows:

- *H₀*: $\phi_{1,j}^+ = \phi_{1,j}^-$;
- *H1*: $\phi_{1,j}^+ \neq \phi_{1,j}^-$;
- *H₀*: $\phi_{2,f}^+ = \phi_{2,f}^-$;
- *H1*: $\phi_{2,f}^+ \neq \phi_{2,f}^-$;
- *H₀*: $\phi_{3,s}^+ = \phi_{3,s}^-$;
- *H1*: $\phi_{3,s}^+ \neq \phi_{3,s}^-$;

2) LR asymmetry with relevant hypotheses stated as:

- *H₀*: $\varphi_1^+ = \varphi_1^-$;
- *H1*: $\varphi_1^+ \neq \varphi_1^-$;
- *H₀*: $\varphi_2^+ = \varphi_2^-$;
- *H1*: $\varphi_2^+ \neq \varphi_2^-$;
- *H₀*: $\varphi_3^+ = \varphi_3^-$;
- *H1*: $\varphi_3^+ \neq \varphi_3^-$.

Accordingly, the null hypothesis proffers SR and LR symmetrical effect as against the alternative which upholds SR and LR asymmetrical impact respectively. The corresponding NARDL bound test for ascertaining LR relation (co-integrating vector) in line with Shin et al. (2014), has tested the following hypotheses:

- *H₀*: $\theta_1 = \varphi_1^+ = \varphi_1^- = \varphi_2^+ = \varphi_2^- = \varphi_3^+ = \varphi_3^- = 0$;
- *H1*: $\theta_1 \neq \varphi_1^+ \neq \varphi_1^- \neq \varphi_2^+ \neq \varphi_2^- \neq \varphi_3^+ \neq \varphi_3^- \neq 0$.

The decision is taken on the basis of the calculated Wald F-statistic and critical values provided. The TY test due to Toda and Yamamoto (1995), was utilized to establish the nature of causality in this paper. This required that we ascertain:

1) the maximum order of integration;
2) the optimal lag given by where is the highest order of integration is VAR lag; the *k* can be determined using different lag information criteria;
3) testing for causality. Performing the TY causality test, the following VAR (*k + dmax*) model was estimated:

$$lnolpv_{it} = \omega_1 + \sum_{i=1}^{k+dmax} \Gamma_{1i} lnolpv_{t-i} + \sum_{j=1}^{k+dmax} \Gamma_{2j} lnsmtr_{t-j} + \sum_{j=1}^{k+dmax} \Gamma_{3j} lnexrv_{t-j} + \sum_{j=1}^{k+dmax} \Gamma_{4j} lnstdr_{t-j} + \varepsilon_{1t} \quad (12)$$

$$lnexrv_{it} = \omega_2 + \sum_{i=1}^{k+dmax} \Phi_{1i} lnexrv_{t-i} + \sum_{j=1}^{k+dmax} \Phi_{2j} lnstdr_{t-j} + \sum_{j=1}^{k+dmax} \Phi_{3j} lnolpv_{t-j} + \sum_{j=1}^{k+dmax} \Phi_{4j} lnsmtr_{t-j} + \varepsilon_{2t} \quad (13)$$

$$lnstdr_{it} = \omega_3 + \sum_{i=1}^{k+dmax} \theta_{1i} lnstdr_{t-i} + \sum_{j=1}^{k+dmax} \theta_{2j} lnexrv_{t-j} + \sum_{j=1}^{k+dmax} \theta_{3j} lnsmtr_{t-j} + \sum_{j=1}^{k+d} \theta_{4j} lnolpv_{t-j} + \varepsilon_{3t} \quad (14)$$

$$lnsmtr_{it} = \omega_4 + \sum_{i=1}^{k+dmax} B_{1i} lnsmtr_{t-i} + \sum_{j=1}^{k+dmax} B_{2j} lnolpv_{t-j} + \sum_{j=1}^{k+dmax} B_{3j} lnexrv_{t-j} + \sum_{j=1}^{k+dmax} B_{4j} lnstdr_{t-j} + \varepsilon_{4t} \quad (15)$$

The optimal lag length is given by $m = (k + d\,max)$ where d is the maximum order of integration amongst the variables, k is chosen VAR lag length, ε_{it} is the errors terms which are assumed to be white noise, $\phi, \delta, \alpha, \gamma, B's, \Phi's, \theta's, \Gamma's$ are parameters of the model. For the bivariate VAR equations above, the H_0 and $H1$ hypotheses are specified as follows:

- H_0: $\sum_{j=1}^{k+dmax} \Gamma_j = 0$
- $H1$: $\sum_{j=1}^{k+dma} \Gamma_j \neq 0$
- H_0: $\sum_{j=1}^{k+dma} \Phi_j = 0$
- $H1$: $\sum_{j=1}^{k+dmax} \Phi_j \neq 0$
- H_0: $\sum_{j=1}^{k+dmax} \theta_j = 0$
- $H1$: $\sum_{j=1}^{k+dmax} \theta_j \neq 0$
- H_0: $\sum_{j=1}^{k+dma} B_j = 0$
- $H1$: $\sum_{j=1}^{k+dmax} B_j \neq 0$

Oil prices were proxied with the log of West Texas Intermediate (WTI) spot oil price and stock returns were modeled from the ASI of the country's stock exchange. The oil-producing African countries include Egypt, Libya, Nigeria, Congo, Gabon, Algeria, and Angola. Nevertheless, due to data availability, the countries in our sample are Egypt, Nigeria, Angola, Libya, and Algeria. Coincidentally, these countries are the leading oil-producing nations in Africa as of 2020, Angola is leading in production with 1.16million barrels per day (mbpd), followed by Nigeria with 1.02mbpd, Algeria with 970 thousand bpd, Libya with 946 thousand bpd, and Egypt with 556,440 bpd (Organization of the Petroleum Exporting Countries [OPEC], 2022).

4. RESEARCH RESULTS

This paper starts its analysis with descriptive statistics shown in Table 1. The huge difference between the maximum and minimum values explains that our variables are changing rapidly and do have a trending interaction with factors over time. The *smrt* and *olpv* are negatively skewed while *exrv* and *stdr* are positively skewed. In using the value of three (3) as the kurtosis benchmark one finds that the curves of all our variables are leptokurtic. The Jarque-Bera probability statistics indicate non-distributional normality for all four of our variables demonstrating non-acceptance of the null hypothesis of distributional normality. With a total number of 600 observations as revealed by the descriptive statistics, we shall continue our analysis starting with our augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) unit root test.

Table 1. Statistical summary

Measures	*smrt*	*olpv*	*exrv*	*stdr*
Mean	0.258245	4.122873	466.0992	121.7691
Median	0.410407	4.082272	12.85125	100.6259
Std. dev.	5.316610	0.352174	813.1437	73.07324
Skewness	-1.402439	-0.385837	1.529986	2.100119
Kurtosis	11.61585	3.331156	3.539514	7.565605
Jarque-Bera	2052.505	17.62867	241.3625	962.1689
Sum	154.9473	2473.724	279659.5	73061.43
Observations	600	600	600	600

Source: Author's elaboration.

We conducted the Bai-Perron manifold breakpoint test due to Bai and Perron (1998, 2002) and found three break dates for Nigeria, two break dates for Tanzania, and one break date for Tunisia and Morocco. This was evident on the basis of significant p-values of the various F-statistics corresponding to break dates. Results are shown in Table 2. A structural break occurs when movement in a series is truncated or when there is a detectable change between the past and future movements in a particular series. Factors responsible for structural breaks in a model include global financial crisis, regime shift, from a floating exchange rate system to a fixed exchange rate, devaluation, deregulation, etc. Austerity measures (increasing taxes/interest rates). Thus, in face of structural break, ADF, PP, etc., are weak in the analysis as these test methods most often mistake a structural break for a unit root.

Table 2. Bai-Perron break dates results

Variable	*Break date*	*F-statistic*	*p-value*
	Egypt		
smtr	-	-	-
olpv	February 2020	159.000	0.0000
exrv	July 1986, July 2016	200.438	0.0000
stdr	-	-	-
	Nigeria		
smtr	-	-	-
olpv	February 2020	145.000	0.0000
exrv	July 1986	178.00	0.0000
stdr	-	-	-
	Tunisia		
smtr	-	-	-
olpv	February 2020	11.100	0.0000
exrv	-	-	-
stdr	-	-	-
	Morocco		
smtr	-	-	-
olpv	February 2020	140.900	0.0000
exrv	-	-	-
Stdr	-	-	-
	Tanzania		
olpv	February 2010	245.10	0.0000
exrv	June 2002	200.438	0.0000
smtr	-	-	-
stdr	-	-	-

Source: Author's elaboration.

In testing for unit root as shown in Table 3, we utilized Zivot-Andrews (Z-A) (1992) method because we found structural breaks that occurred during the study period. Table 2 shows that stock returns were found to be stationary at a level for Egypt but only after the first difference for Nigeria and other countries. The log of oil price variations, however, is stationary. The *olpv* was found to be stationary in the first difference with p-values significant at the 1% level of significance. Exchange rate devaluation (*exrv*) and *stdr* were only stationary in the first difference just as seen in the case of *olpv*. Only returns were stationary at level.

Table 3. Stationarity results

Variable	*Z-A statistic(s)*		*Remark*
	Level	*Difference*	
	Egypt		
smtr	61.068***	-	*I*(0)
olpv	2.179	7.541***	*I*(1)
exrv	1.746	4.598***	*I*(1)
stdr	1.161	4.611***	*I*(1)
	Nigeria		
smtr	18.220***	-	*I*(0)
olpv	1.0286	25.942***	*I*(1)
exrv	1.068	30.543***	*I*(1)
stdr	1.123	23.691***	*I*(1)
	Tunisia		
smtr	4.689**	-	*I*(0)
olpv	2.199	46.254***	*I*(1)
exrv	2.846	4.981**	*I*(1)
stdr	5.16711***	-	*I*(0)
	Morocco		
smtr	6.918***	-	*I*(0)
olpv	2.199	28.940***	*I*(1)
exrv	6.746***	-	*I*(0)
stdr	4.794**	-	*I*(0)
	Tanzania		
smtr	22.015***	-	*I*(0)
olpv	1.179	10.918***	*I*(1)
exrv	6.846***	-	*I*(0)
stdr	2.011	51.161***	*I*(1)

*Note: **, *** significance at 5% and 1% levels.*
Source: Author's elaboration.

Given a VAR lag of one for each country as selected by information criteria and maximum order of integration as reported by the Z-A unit root test, we had an optimal lag length of 2. Hence, we conducted the TY Granger causality (GC) test with results reported in Table 4. The GC results revealed a unidirectional cause-effect relation from *olpv* to returns, *exrv* to returns, and *stdr* to returns respectively for all countries in our sample.

Table 4. Causality results

Variables	*lag (k + d max)*	*Chi-square*	*Prob.*	*Direction*
Egypt				
olpv does not cause *stmr*	2	54.759***	0.000	*olpv* → *stmr*
stmr does not cause *olpv*	2	1.278	0.578	
exrv does not cause *stmr*	2	10.384**	0.004	*exrv* → *stmr*
stmr does not cause *exrv*	2	1.676	0.128	
stdr does not cause *stmr*	2	19.214***	0.000	*stdr* → *stmr*
stmr does not cause *stdr*	2	0.892	0.468	
Nigeria				
olpv does not causes *stmr*	2	27.526***	0.000	*olpv* → *stmr*
stmr does not cause *olpv*	2	2.045	0.597	
exrv does not cause *stmr*	2	278.180***	0.000	*exrv* → *stmr*
stmr does not cause *exrv*	2	2.489	0.289	
stdr does not cause *stmr*	2	40.091***	0.000	*stdr* → *stmr*
Tunisia				
olpv does not cause *stmr*	2	120.459***	0.000	*olpv* → *stmr*
stmr does not cause *olpv*	2	0.248	0.295	
exrv does not cause *stmr*	2	200.1029**	0.000	*exrv* → *stmr*
stmr does not cause *exrv*	2	0.785	0.506	
stdr does not cause *stmr*	2	56.578***	0.000	*stdr* → *stmr*
Morocco				
olpv does not causes *stmr*	2	267.180***	0.000	*olpv* → *stmr*
stmr does not cause *olpv*	2	0.295	0.278	
exrv does not cause *stmr*	2	191.104***	0.000	*exrv* → *stmr*
stmr does not cause *exrv*	2	2.789	0.576	
stdr does not cause *stmr*	2	60.785***	0.000	*stdr* → *stmr*
Tanzania				
olpv does not cause *stmr*	2	114.567***	0.000	*olpv* → *stmr*
stmr does not cause *olpv*	2	2.349	0.198	
exrv does not cause *stmr*	2	500.784**	0.000	*exrv* → *stmr*
stmr does not cause *exrv*	2	0.479	0.458	
stdr does not cause *stmr*	2	200.512***	0.000	*stdr* → *stmr*

*Note: *** (**) 1% (5%) significance levels.*
Source: Author's elaboration.

For our test of co-integration results of Table 5, the estimated Wald F-value exceeded all critical values (CV) both at the lower and upper bound, signifying the presence of LR relation at a 5% level.

Table 5. Bounds test results

Results				
k	*F-statistic*	*CV*	*I(0)*	*I(1)*
Egyptian Model — ARDL (4, 0.0, 0)				
3	4.786***	5%	3.597	4.086
Nigerian Model — ARDL (2, 1.0, 0)				
3	4.786***	5%	3.597	4.086
Tunisian Model — ARDL (2, 0.0, 1)				
3	4.786***	5%	3.597	4.086
Moroccan Model — ARDL (1, 1.0, 0)				
3	4.786***	5%	3.597	4.086
Tanzanian Model — ARDL (2, 0.0, 1)				
3	4.786***	5%	3.597	4.086

*Note: *** 5% significance level.*
Source: Author's elaboration.

Table 6 reports significant LR and SR coefficients of asymmetric effects of oil price variability and exchange rate devaluation for all countries while short-term deposit rate had no asymmetric effect. In particular, a positive shock on *olpv* resulted in a negative impact on stock market returns while a negative shock (reduction in oil price variation) positively impacted returns. This result is the same for all the markets. Similarly, the *exrv* had asymmetric effects on returns except in Egypt where both appreciation and devaluation contributed negatively to determining stock returns. In other words, an appreciation in the local exchange rate to USD negatively influenced returns while a devaluation positively influenced returns. The estimates show that in LR, both positive and negative shocks to oil prices, influenced *smrt* inversely in Egypt while for other countries the effect is non-linear. All adjustment coefficients are significant and well-signed implying the possibility of convergence to LR equilibrium whenever there was a disturbance in the SR determination of returns. Our models are well specified considering the values of the LM test and ARCH test respectively for each country.

Table 6. Asymmetric effects (Part 1)

Variable	*Egypt*	*Nigeria*	*Tunisia*	*Morocco*	*Tanzania*
	Coefficient	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
LR results					
$ln\, stmr_{t-1}$	0.042 (2.891)**	1.089 (2.702)**	0.892 (5.700)***	0.281 (6.279)***	1.027 (5.289)***
$ln\, stmr_{t-2}$	0.201 (9.281)***	0.189 (2.104)**	0.878 (2.568)**	0.048 (19.579)***	0.281 (2.589)**
$ln\, olpv^{+}_{t-1}$	-0.021 (-2.167)**	-0.051 (-11.291)	-0.180 (-2.094)**	-1.091 (-2.481)**	-0.245 (-9.891)***
$ln\, olpv^{-}_{t-1}$	1.024 (12.045)***	0.128 (4.589)***	0.199 (2.481)**	1.0289 (2.497)**	0.091 (5.412)***
$ln\, exrv^{+}_{t-1}$	-1.012 (-2.076)**	-1.043 (-2.098)**	-0.015 (-2.099)**	-0.112 (-2.786)**	-0.214 (-6.890)***
$ln\, exrv^{-}_{t-1}$	-1.015 (-7.891)***	-2.191 (17.201)***	0.118 (4.006)***	0.176 (9.098)***	1.145 (2.576)**

Table 6. Asymmetric effects (Part 2)

Variable	*Egypt*	*Nigeria*	*Tunisia*	*Morocco*	*Tanzania*
	Coefficient	*Coefficient*	*Coefficient*	*Coefficient*	*Coefficient*
LR results					
$ln\, stdr^{+}_{t-1}$	-0.0112 (-2.119)**	-0.761 (-2.489)**	-0.192 (-4.578)***	-0.112 (-2.158)**	-0.284 (4.598)***
$ln\, stdr^{-}_{t-1}$	-0.841 (-1.894)	-0.192 (-2.489)**	-0.102 (-2.091)**	-0.192 (-5.489)***	-0.289 (-10.987)***
SR results					
ecm_{t-1}	-0.541 (-10.011)	-0.6201 (-20.879)	-0.455 (-8.857)	-0.456 (-12.409)	-0.648 (-2.102)**
$\Delta\, ln\, tmr_{t-1}$	0.0101 (11.549)***	1.044 (4.578)***	0.478 (14.578)***	1.048 (4.585)***	1.209 (15.689)***
$\Delta\, ln\, olpv^{+}_{t}$	-0.659 (-2.0167)**	-0.182 (-9.014)***	-0.2897 (-2.487)	1.082 (14.578)	-0.291 (6.489)***
$\Delta\, ln\, olpv^{-}_{t}$	1.2036 (11.698)	0.257 (4.589)	0.246 (4.278)	1.028 (5.894)	0.489 (7.845)
$\Delta\, ln\, exdv^{+}_{t}$	-1.803 (-2.854)**	-1.078 (-9.478)	-0.1289 (-10.021)	-0.265 (5.761)	-0.781 (2.489)
$\Delta\, ln\, exdv^{-}_{t}$	-0.281 (-1.854)	0.093 (2.490)**	0.289 (2.628)**	0.189 (4.581)***	0.784 (6.029)***
$\Delta\, ln\, stdr^{+}_{t}$	-0.231 (-5.079)***	-0.984 (2.021)**	-0.109 (2.489)**	-0.281 (5.108)***	-0.289 (14.558)***
$\Delta\, ln\, stdr^{-}_{t}$	-0.341 (-2.890)**	-0.927 (2.940)**	-0.209 (4.589)***	-0.102 (2.489)**	-0.281 (5.897)***
C	1.048 (9.894)***	0.471 (5.768)***	0.174 (10.109)***	0.124 (2.478)**	1.084 (6.489)***
χ^2 (SC)	0.461(0.684)	0.246(0.671)	0.297(0.468)	0.192(0.785)	0.784(0.468)
χ^2 (ARCH)	0.297(0.271)	0.110(0.941)	0.468(0.622)	0.570(0.658)	0.128(0.992)
Adj. R^2	0.602	0.720	0.678	0.845	0.620
Std. error of reg.	0.048	1.084	0.048	0.2289	1.0292

Note: t-values are indicated in brackets.
Source: Author's elaboration.

The asymmetric effect was tested by using the Wald coefficient restriction test. The results as presented in Tables 7 and 8 revealed both LR and SR significance of asymmetric effects for oil price variation and returns as well as exchange rate and returns respectively. This follows from the significance of the Wald F-test statistic.

Table 7. Testing SR asymmetric effects (Part 1)

Variable	*Hypotheses*	*Wald statistic*	*p-value*
	Egypt		
$\Delta\, ln\, olpv$	H_0: $\phi^{+}_{1,j} = \phi^{-}_{1,j}$ $H1$: $\phi^{+}_{1,j} \neq \phi^{-}_{1,j}$	26.094***	0.000
$\Delta\, ln\, exrv$	H_0: $\phi^{+}_{2,f} = \phi^{-}_{2,f}$ $H1$: $\phi^{+}_{2,f} \neq \phi^{-}_{2,f}$	1.469	0.561
$\Delta\, ln\, stdr$	H_0: $\phi^{+}_{3,s} = \phi^{-}_{3,s}$ $H1$: $\phi^{+}_{3,s} \neq \phi^{-}_{3,s}$	0.478	0.514
	Nigeria		
$\Delta\, ln\, olpv$	H_0: $\phi^{+}_{1,j} = \phi^{-}_{1,j}$ $H1$: $\phi^{+}_{1,j} \neq \phi^{-}_{1,j}$	23.094***	0.000
$\Delta\, ln\, exrv$	H_0: $\phi^{+}_{2,f} = \phi^{-}_{2,f}$ $H1$: $\phi^{+}_{2,f} \neq \phi^{-}_{2,f}$	14.560***	0.000
$\Delta\, ln\, stdr$	H_0: $\phi^{+}_{3,s} = \phi^{-}_{3,s}$ $H1$: $\phi^{+}_{3,s} \neq \phi^{-}_{3,s}$	1.357	0.678
	Tunisia		
$\Delta\, ln\, olpv$	H_0: $\phi^{+}_{1,j} = \phi^{-}_{1,j}$ $H1$: $\phi^{+}_{1,j} \neq \phi^{-}_{1,j}$	405.012***	0.000
$\Delta\, ln\, exrv$	H_0: $\phi^{+}_{2,f} = \phi^{-}_{2,f}$ $H1$: $\phi^{+}_{2,f} \neq \phi^{-}_{2,f}$	10.485***	0.000
$\Delta\, ln\, stdr$	H_0: $\phi^{+}_{3,s} = \phi^{-}_{3,s}$ $H1$: $\phi^{+}_{3,s} \neq \phi^{-}_{3,s}$	2.489	0.461
	Morocco		
$\Delta\, ln\, olpv$	H_0: $\phi^{+}_{1,j} = \phi^{-}_{1,j}$ $H1$: $\phi^{+}_{1,j} \neq \phi^{-}_{1,j}$	130.241***	0.000
$\Delta\, ln\, exrv$	H_0: $\phi^{+}_{2,f} = \phi^{-}_{2,f}$ $H1$: $\phi^{+}_{2,f} \neq \phi^{-}_{2,f}$	299.471***	0.000
$\Delta\, ln\, stdr$	H_0: $\phi^{+}_{3,s} = \phi^{-}_{3,s}$ $H1$: $\phi^{+}_{3,s} \neq \phi^{-}_{3,s}$	0.0481	0.827

Table 7. Testing SR asymmetric effects (Part 2)

Variable	*Hypotheses*	*Wald statistic*	*p-value*
	Tanzania		
$\Delta\, ln\, olpv$	H_0: $\phi^+_{1,j} = \phi^-_{1,j}$ $H1$: $\phi^+_{1,j} \neq \phi^-_{1,j}$	1209.578***	0.000
$\Delta\, ln\, exrv$	H_0: $\phi^+_{2,f} = \phi^-_{2,f}$ $H1$: $\phi^+_{2,f} \neq \phi^-_{2,f}$	829.578***	0.000
$\Delta\, ln\, stdr$	H_0: $\phi^+_{3,s} = \phi^-_{3,s}$ $H1$: $\phi^+_{3,s} \neq \phi^-_{3,s}$	2.4769	0.425

*Note: *** (**) 1% (5%) significance levels.*
Source: Author's elaboration.

Table 8. Testing LR asymmetric effects

Variable	*Hypotheses*	*Wald statistic*	*p-value*
	Egypt		
$\Delta\, ln\, olpv$	H_0: $\varphi^+_1 = \varphi^-_1$ $H1$: $\varphi^+_1 \neq \varphi^-_1$	190.175***	0.002
$\Delta\, ln\, exrv$	H_0: $\varphi^+_2 = \varphi^-_2$ $H1$: $\varphi^+_2 \neq \varphi^-_2$	2.685	0.489
$\Delta\, ln\, stdr$	H_0: $\varphi^+_3 = \varphi^-_3$ $H1$: $\varphi^+_3 \neq \varphi^-_3$	0.985	0.864
	Nigeria		
$\Delta\, ln\, olpv$	H_0: $\varphi^+_1 = \varphi^-_1$ $H1$: $\varphi^+_1 \neq \varphi^-_1$	123.547***	0.002
$\Delta\, ln\, exrv$	H_0: $\varphi^+_2 = \varphi^-_2$ $H1$: $\varphi^+_2 \neq \varphi^-_2$	10.456***	0.000
$\Delta\, ln\, stdr$	H_0: $\varphi^+_3 = \varphi^-_3$ $H1$: $\varphi^+_3 \neq \varphi^-_3$	1.042	0.652
	Tunisia		
$\Delta\, ln\, olpv$	H_0: $\varphi^+_1 = \varphi^-_1$ $H1$: $\varphi^+_1 \neq \varphi^-_1$	219.405***	0.000
$\Delta\, ln\, exrv$	H_0: $\varphi^+_2 = \varphi^-_2$ $H1$: $\varphi^+_2 \neq \varphi^-_2$	112.029***	0.000
$\Delta\, ln\, stdr$	H_0: $\varphi^+_3 = \varphi^-_3$ $H1$: $\varphi^+_3 \neq \varphi^-_3$	0.094	0.742
	Morocco		
$\Delta\, ln\, olpv$	H_0: $\varphi^+_1 = \varphi^-_1$ $H1$: $\varphi^+_1 \neq \varphi^-_1$	27.486***	0.000
$\Delta\, ln\, exrv$	H_0: $\varphi^+_2 = \varphi^-_2$ $H1$: $\varphi^+_2 \neq \varphi^-_2$	297.710***	0.000
$\Delta\, ln\, stdr$	H_0: $\varphi^+_3 = \varphi^-_3$ $H1$: $\varphi^+_3 \neq \varphi^-_3$	2.871	0.112
	Tanzania		
$\Delta\, ln\, olpv$	H_0: $\varphi^+_1 = \varphi^-_1$ $H1$: $\varphi^+_1 \neq \varphi^-_1$	123.48***	0.000
$\Delta\, ln\, exrv$	H_0: $\varphi^+_2 = \varphi^-_2$ $H1$: $\varphi^+_2 \neq \varphi^-_2$	12.416**	0.012
$\Delta\, ln\, stdr$	H_0: $\varphi^+_3 = \varphi^-_3$ $H1$: $\varphi^+_3 \neq \varphi^-_3$	2.489	0.129

*Note: *** (**) 1% (5%) significance levels.*
Source: Author's elaboration.

An inverse roots AR characteristics polynomial test was also carried out and showed our model to be stable (see Appendix).

5. DISCUSSION

The paper finds long and short-run significant asymmetric effects of oil price variability for all countries. In particular, a 1% positive shock on *olpv* resulted in a negative impact of 0.02%, 0.05%, 0.18%, 1.09%, and 0.25% stock market returns in Egypt, Nigeria, Tunisia, Morocco, and Tanzania respectively while a 1% negative shock stimulated stock returns to the tune of 1.02%, 0.128%, 0.199%, 1.029%, and 0.091% in Egypt, Nigeria, Tunisia, Morocco, and Tanzania respectively. These findings are reinforced by the previous studies carried out by Arouri and Fouquau (2009). Having based analysis on the VAR model, their findings revealed that stock markets reacted positively to oil price escalations. This is attributable to the asymmetric price transmission theory which advocates that the absence of clear information does cause asymmetry. Also, our findings of SR asymmetric effects are a pointer to a shorter time window, implying time is excessively short for the influence of new information on prices to cause a significant shift. However, in LR, the market is efficient enough to resolve variations in its performance. The inverse association between returns and oil prices is in line with economic theories such as the linear theory of growth by Hamilton (1983) which states that there is a negative relationship between oil prices and growth. Direct and significant asymmetric effects of a reduction in oil price variation agree with the findings of Lee et al. (1995).

The paper also explores the fact that changes in exchange rates were found to impose significantly different (asymmetric) effects on returns in oil-producing nations in Africa. The NARDL estimation divulges that positive exchange rate changes influence return significantly albeit negatively with a 1.012%, 1.04%, 0.015%, 0.112%, and 0.214% decline in returns on every 1% positive shock to exchange rates in Egypt, Nigeria, and Tunisia, Morocco, and Tanzania respectively. This result contradicts the findings of Nwani and Okogbue (2017). On the other hand, NARDL results reveal that for every 1% negative shock to the exchange rate, returns were significantly diminished by 1.015% and 2.191% for Egypt and Nigeria respectively whereas in Tunisia, Morocco, and Tanzania stock returns were increased significantly by 0.118%, 0.176%, and 1.145% respectively. In particular, our study unravels exchange rate had both SR and LR asymmetric influence on returns for all countries as appreciation and devaluation in the exchange rate of all countries except Egypt contributed opposing effects (positively and negatively respectively) in determining stock returns. This confirms a non-linear effect of exchange rate movements on returns. The findings revalidated the findings of asymmetric exchange rate disclosure of stock returns of Cuestas and Tang (2015), and Habibi and Lee (2019) who reported that exchange rate changes had SR asymmetric effects on stock prices for all G7 nations and LR asymmetric exchange rate effects were reported for Germany. Our findings also supported those obtained by Rahman (2022) where returns reacted asymmetrically to rising and falling oil price shockwaves, and also LR and SR non-linear effects of oil price movements on returns of the Shanghai stock market. Our study is also in line with research done by Zarour (2006). Our findings were also reinforced by the previous studies carried out by Arouri and Fouquau (2009) who revealed that while the exchange rate had a direct negligible relationship with the oil price, the Brent price had a strong negative influence on ASI which was a proxy for stock market capitalization. In testing for the asymmetry between oil prices and ASI, positive shocks on *olpv* were found to be insignificant and inverse while negative shocks in the short run were found to be direct and significant. Finally, our findings also corroborated those of Lee et al. (1995).

6. CONCLUSION

This paper analyzes the influence of changes in oil prices, exchange rates, and deposit rates of interest on stock returns in oil-producing African countries, namely Egypt, Nigeria, Tunisia, Morocco, and Tanzania over the period, 1980–2022. The paper found long and SR significant asymmetric effects of oil price variability for all countries. In particular, a 1% positive shock on oil price variability was found to negatively influence returns by 0.02%, 0.05%, 0.18%, 1.09%, and 0.25% in Egypt, Nigeria, Tunisia, Morocco, and Tanzania respectively while a 1% negative shock stimulated stock returns by 1.02%, 0.128%, 0.199%, 1.029%, and 0.091% in Egypt, Nigeria, Tunisia, Morocco, and Tanzania respectively. These findings are reinforced by the previous studies carried out by Arouri and Fouquau (2009) as against those by Alamgir and Amin (2021) who found positive asymmetric relation between oil prices and stock prices in south Asian.

The NARDL estimation also reveals that positive exchange rate changes declined stock returns. For every 1% positive shock to exchange rates in Egypt, Nigeria, Tunisia, Morocco, and Tanzania, returns declined by 1.012%, 1.04%, 0.015%, 0.112%, and 0.214% respectively. This result contradicts the findings of Nwani and Okogbue (2017). On the other hand, NARDL results reveal that for every 1% negative shock to the exchange rate, returns were significantly diminished by 1.015% and 2.191% for Egypt and Nigeria respectively whereas in Tunisia, Morocco, and Tanzania stock returns were increased significantly by 0.118%, 0.176%, and 1.145% respectively. In general, our study disentangles SR and LR asymmetric impact of exchange rate changes on stock returns except in Egypt as appreciation and devaluation in exchange rates resulted in opposing in determining the volume of returns. This confirms a non-linear effect of exchange rate movements on returns. The findings revalidated the findings of asymmetric exchange rate disclosure of stock returns of Cuestas and Tang (2015), and Habibi and Lee (2019) where LR asymmetric exchange rate effects were reported for returns in the German market.

Our findings also supported those obtained by Rahman (2022) where returns reacted asymmetrically to oil price shockwaves, and also LR and SR asymmetric effects of oil price movements on returns of the Shanghai stock market. In Egypt, exchange rate depreciation and appreciation contributed 0.01% and 0.04% reduction in returns. In line with the findings of this paper it is recommended that due to the massive impact of negative shocks imposed on returns of oil-producing African nations, it is paramount that different policy reaction functions be executed differently for depreciation and appreciation to enhance the favorable flow of returns in stock markets. This will help cushion exchange rate shocks in the system. Furthermore, the gross capital formation of these countries should be enhanced to diversify the economies away from petroleum activities. Investors may also rest easy and not get overly agitated due to fluctuations in the stock markets caused by shocks in oil prices as whatever volatility is being imposed or transmitted will converge to equilibrium almost instantaneously. The findings of the present paper do not provide threshold values of exchange rates and oil prices that stimulate stock returns. This is a limitation of the study. Hence, future studies should extend a panel threshold estimation of the variables needed to stimulate returns with control for the volume of foreign exchange reserves in the model analysis for both oil-exporting and oil-importing countries.

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APPENDIX

Figure A.1. Stability test results for Egypt

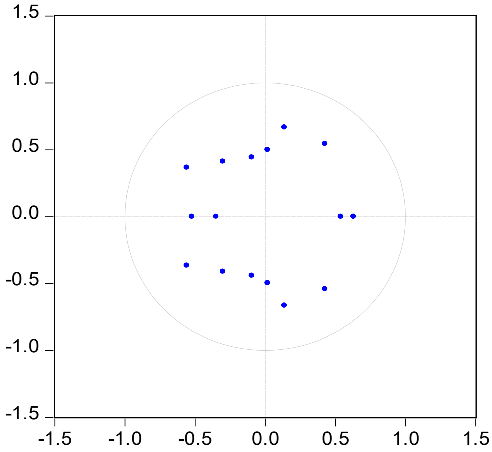

Figure A.2. Stability test results for Nigeria

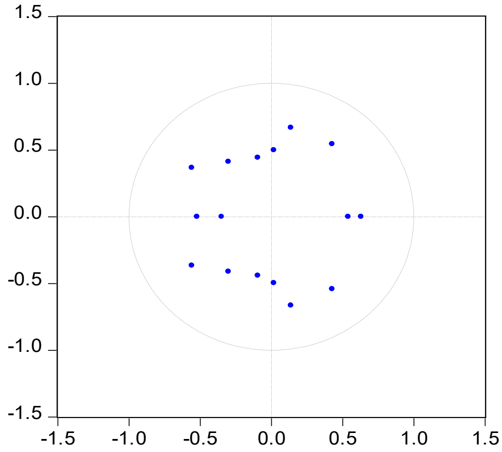

Figure A.3. Stability test results for Tunisia

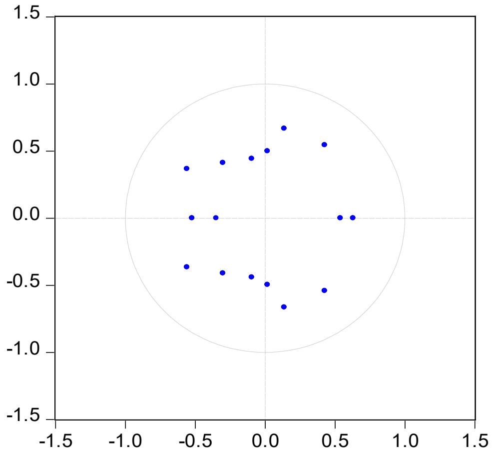

Figure A.4. Stability test results for Morocco

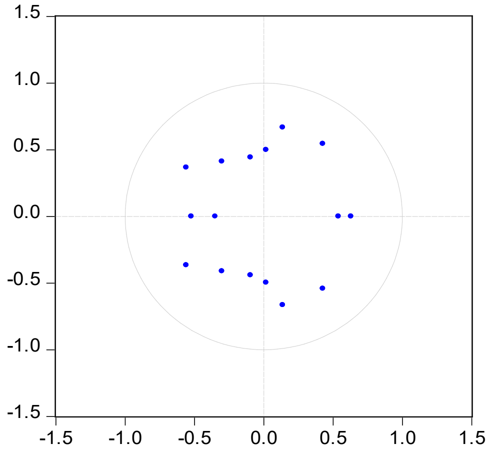

Figure A.5. Stability test results for Tanzania